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OBSERVATIONS ON STUDIES USEFUL TO ASBESTOS O&M ACTIVITIES

by

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16. ABSTRACT

Buildings that contain ACM (asbestos-containing-materials) may present unique problems for custodial workers. The release of asbestos by aging and deteriorated ACM is known to be episodic, relating to a myriad of factors such as activity within the area, vibration, temperature, humidity, airflow, use patterns, etc. Hopefully, for the majority of buildings containing ACM, fiber release is minimal. If a building contains asbestos and releases occur, the custodial worker may be most intensely affected over the long term. If a release occurs, much of the asbestos will eventually settle and attach to the surfaces of the rooms (walls, furnishings, equipment, floors, and carpet). The preliminary analysis of dusty environments is presented for the micro-vac, sonification, and passive air current sampling methodlogies.

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INTRODUCTION/RISKS

Buildings that contain ACM (asbestos-containing-materials) may present unique problems for custodial workers. The release of asbestos by aging and deteriorated ACM is known to be episodic, relating to a myriad of factors such as activity within the area, vibration, temperature, humidity, airflow, use patterns, etc. Hopefully, for the majority of buildings containing ACM, fiber release is minimal; however, since we are unable at this point in time to make accurate predictions on this, prudent judgment should prevail for the protection of building occupants and workers. The assumption is therefore made that special precautions must be taken for buildings containing asbestos. This conservative approach is necessary because asbestos is a known human carcinogen. In the absence of contradictory data, health scientists (1) feel that the carcinogenicity of asbestos follows

a linear, zero-threshold model, which means that

1) inhaling a single fiber represents a risk

2) doubling the exposure doubles the risk, and so on.

The inhalation of asbestos can result in the following diseases:

a) asbestosis -- a debilitating lung disease similar to silicosis,

b) lung cancer-- a usually fatal lung malignancy,

and/or

c) mesothelioma-- an incurable, fatal cancer of the mesothelial lining of the chest.

The absolute risks have been difficult to define because of the latency period (time between exposure and onset of symptoms), which for these asbestos-related diseases may be twenty or more years. It is known that smoking increases these risks by at least a factor of ten. EPA(2) estimates that between 3000 and 13000 deaths each year in the US are attributable to asbestos.

If a building contains asbestos and releases occur, the custodial worker may be most intensely affected over the long term. If a release occurs, much of the asbestos will eventually settle and attach to the surfaces of the rooms (walls, furnishings, equipment, floors, and carpet). As the custodial worker repeatedly cleans and dusts these rooms, the energy imparted by these activities may re-entrain the asbestos into the air, resulting in potentially chronic long-term exposures. Activities like dusting, sweeping, and vacuuming are mechanically aggressive and are most likely to re-entrain dust and presumably

differs from the ones used today for asbestos sampling and is undoubtedly more efficient although less practical. Additional work on the current microvac technique is needed to fully characterize its performance on a variety of surfaces and under a range of loadings.

In Figure 1, the efficiencies of three sampling techniques studied for nuclear applications are demonstrated for three size fractions of particulates. It is logical that these relationships should be generally similar to those for asbestos, although no data are available at this time to support or refute this. Similarly, the analytical protocols in use today have not been standardized, further complicating the problems of using any of the procedures. Again, asbestos fibers and structures fall within the size areas addressed by Figure 1. Most airborne asbestos structures in post-abatement monitoring studies performed by EPA are shorter than five microns; in fact, 99 percent fall below the five-micron long, 3:1 minimum aspect ratio PCM counting rules. This relates to why EPA prefers not to recommend PCM for post-abatement asbestos clearance use and instead recommends TEM. We assume that dust-laden samples contain generally similar size distributions, except that the smaller individual fibers may have agglomerated into matrices (a mixture of fibers and other materials, stuck together); however, dust particles may not represent airborne particles as the dust size distribution may reflect larger aggregates that have preferentially settled. Additional data evaluation is needed on this topic.

In Figure 2, typical asbestos values in the surface dust are presented for a variety of sites containing ACM. As expected, a

asbestos.

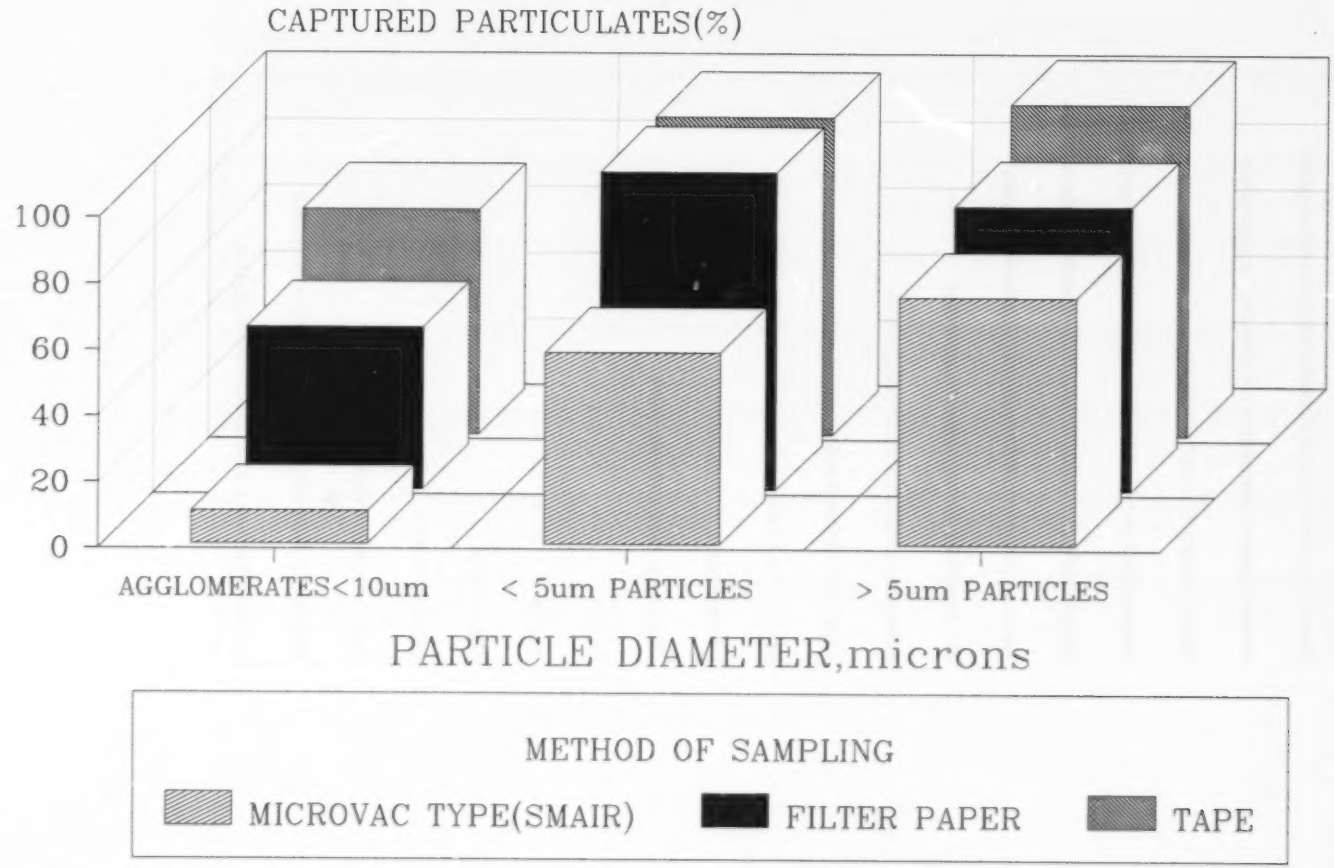
To date, very little research has been devoted to these areas and concerns. This paper discusses data that are largely observational in nature but are illustrative of general trends of interest to those individuals dealing with the day-to-day problems of asbestos in buildings.

DUST

In the future, surface sampling (dust sampling) of some type may be the most useful indicator of contamination, because of the unpredictable, episodic releases of asbestos from ACM.

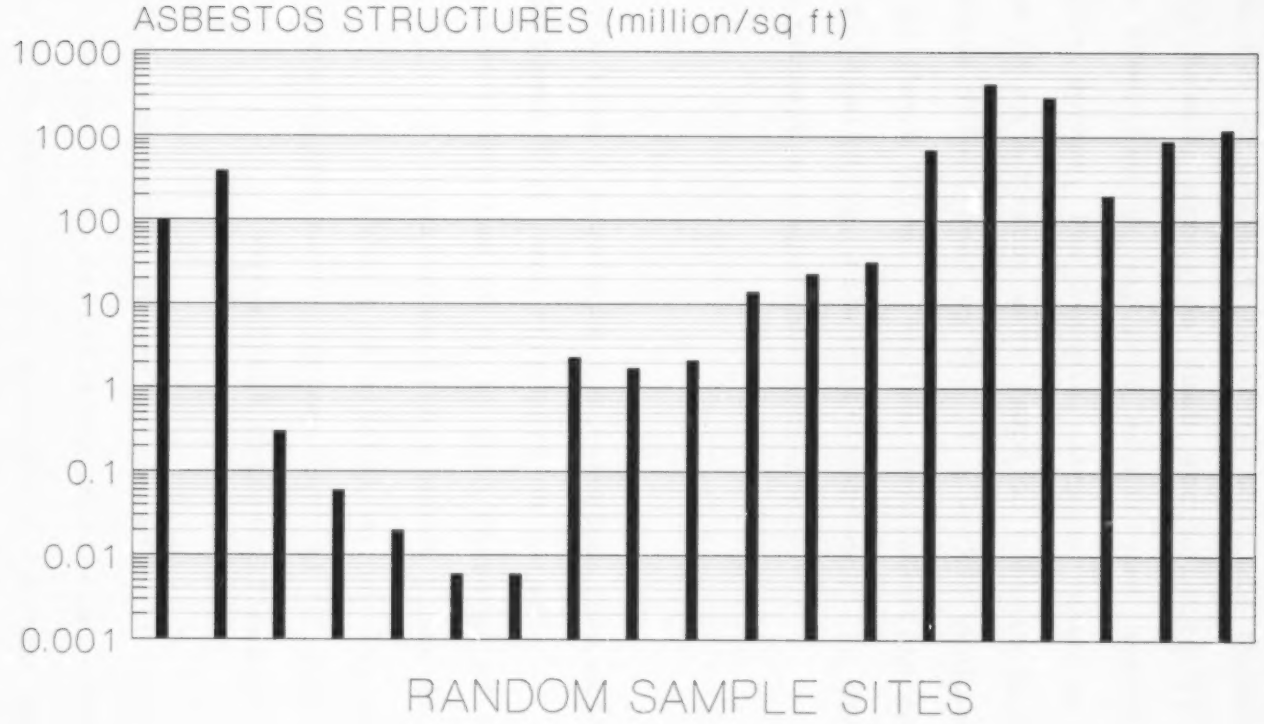
Currently, there are a variety of techniques being studied for sampling and analysis of dust. The new committee of the National Asbestos Council will evaluate various methods of surface sampling and analysis. The background for most of these techniques relates to intense work done years ago for the nuclear industry (3). From the nuclear work, which related to the ability of various surface sampling techniques to recover small particulates from surfaces, it was observed that extremely small particulates (below two microns) require local airflow (sampling) velocities near 100 miles per hour to overcome surface attraction forces and dislodge the particulates for recovery by an air sampling apparatus. Many asbestos fibers observed by TEM are in this size range. To achieve this high sampling velocity, a special micro-vac sampling cowl, called a SMAIR sampler, was used. This cowl cap utilized specially designed orifices drilled at unique angles to achieve the high velocities. This microvac technique

Figure 1. EFFICIENCY OF DUST COLLECTION ON HARD SURFACES



ROYSTER AND FISH; June 1964

Figure 2. DUST ANALYSES TYPICAL VALUES



ANALYSES BY TEM -MICROVAC

wide range is evident--from 6000 asbestos structures/sq ft to over four billion/sq ft, averaging near one million asbestos structures/sq ft. In addition to areas that are normally cleaned on a routine basis, asbestos dust accumulates in normally-unaccessible areas, which may pose significant health threat to the maintenance worker. For example, samples taken on the top of ceiling tiles in an ACM-area were found to contain as high as 1.2 billion asbestos structures/ sq ft. If a worker would unknowingly pop-out one of those tiles, a serious contamination and exposure could result. Similarly, asbestos-laden-dust in inaccessible ductwork may present a comparable scenario.

CARPET

Carpet acts like a reservoir for asbestos. Two major types of sampling techniques have been attempted on carpet:

1) microvac-- use of a) an open cassette or b) a closed cassette with a short piece of Tygon tubing as a sampling nozzle, and
2) bulk-carpet sonification--removal of a plug of carpet and ultrasonification.

The sonification technique sacrifices a small bulk sample of the actual carpet for destructive analysis. Although the sonification technique should provide a better estimate of contamination, it is obviously not going to become popular with building owners, who are unlikely to appreciate the utility of sacrificing pieces of their carpets for testing.

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Typical values for microvac are shown in Figure 3 and Figure 4 illustrates sonification values. Not unlike the dust data, the carpet microvac values range from about 8000 asbestos structures/sq ft to two billion structures/sq ft, averaging about one million asbestos structures/sq ft. Bulk sample carpet sonification (Figure 4) produced values starting at 30 million/sq ft and ranging to four billion/sq ft, averaging about 100 million/sq ft. Figure 5 shows carpet data averaged for each of 12 sites. In two of the 12, both sonification and microvac analyses were made. The sonification values were 100 times and 20 times higher than the respective microvac analyses.

TIME

In a ACM-containing office building, samples were taken in a number of similar rooms in which the owner was able to document the last date that the cleaning service had cleaned that particular area. Assuming somewhat uniform conditions existed from one room to the next, the data in Figures 6 to 8 are useful only to the extent of illustrating the general trend of asbestos accumulation with time, both in the dust and in the carpet.

TYPICAL INDOOR AIR ASBESTOS LEVELS

In Figure 9, typical air levels are presented for some of the sites where dust and carpet samples were obtained. On the day that the samples were taken, most of the values were quite low, but three of the sites had elevated levels. As a reference,

Figure 3. CARPET MICROVAC ANALYSES TYPICAL LEVELS

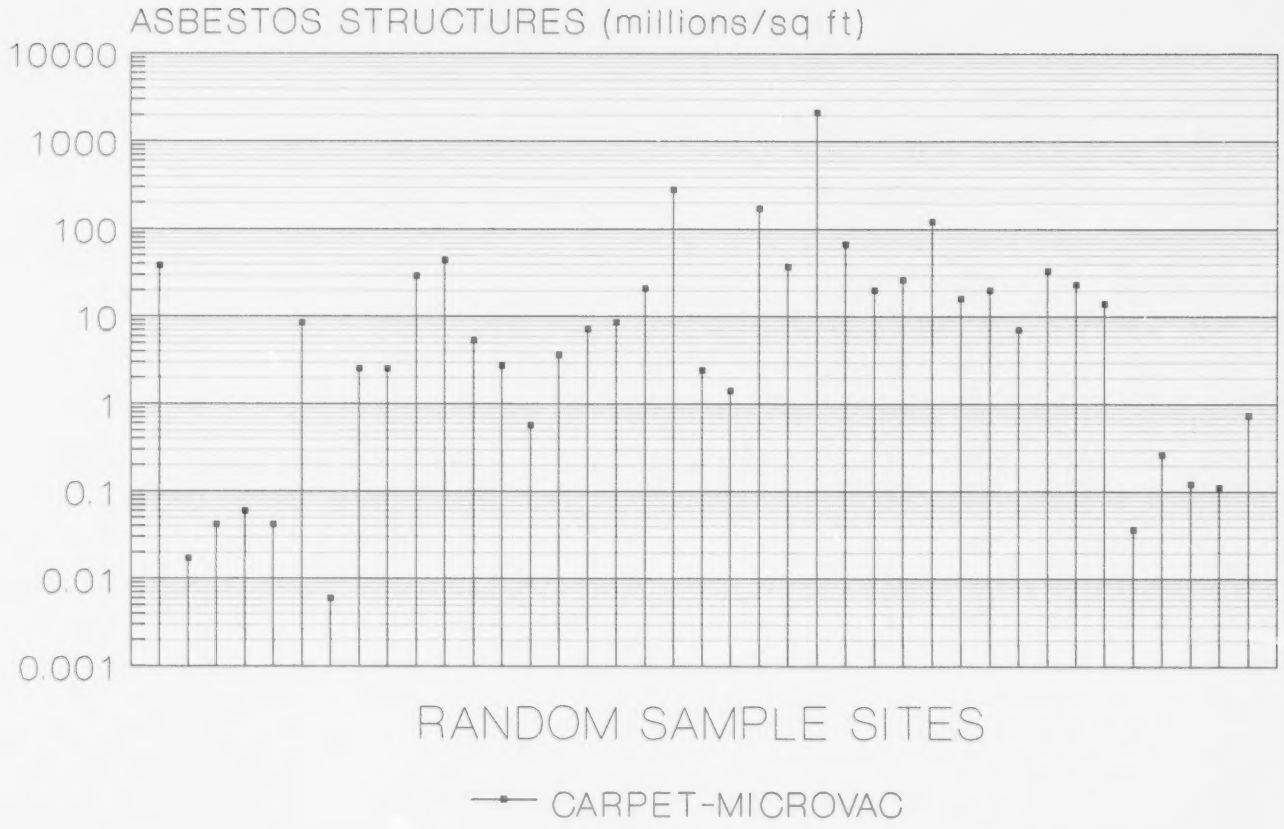


Figure 4. CARPET SONIFICATION ANALYSES TYPICAL LEVELS

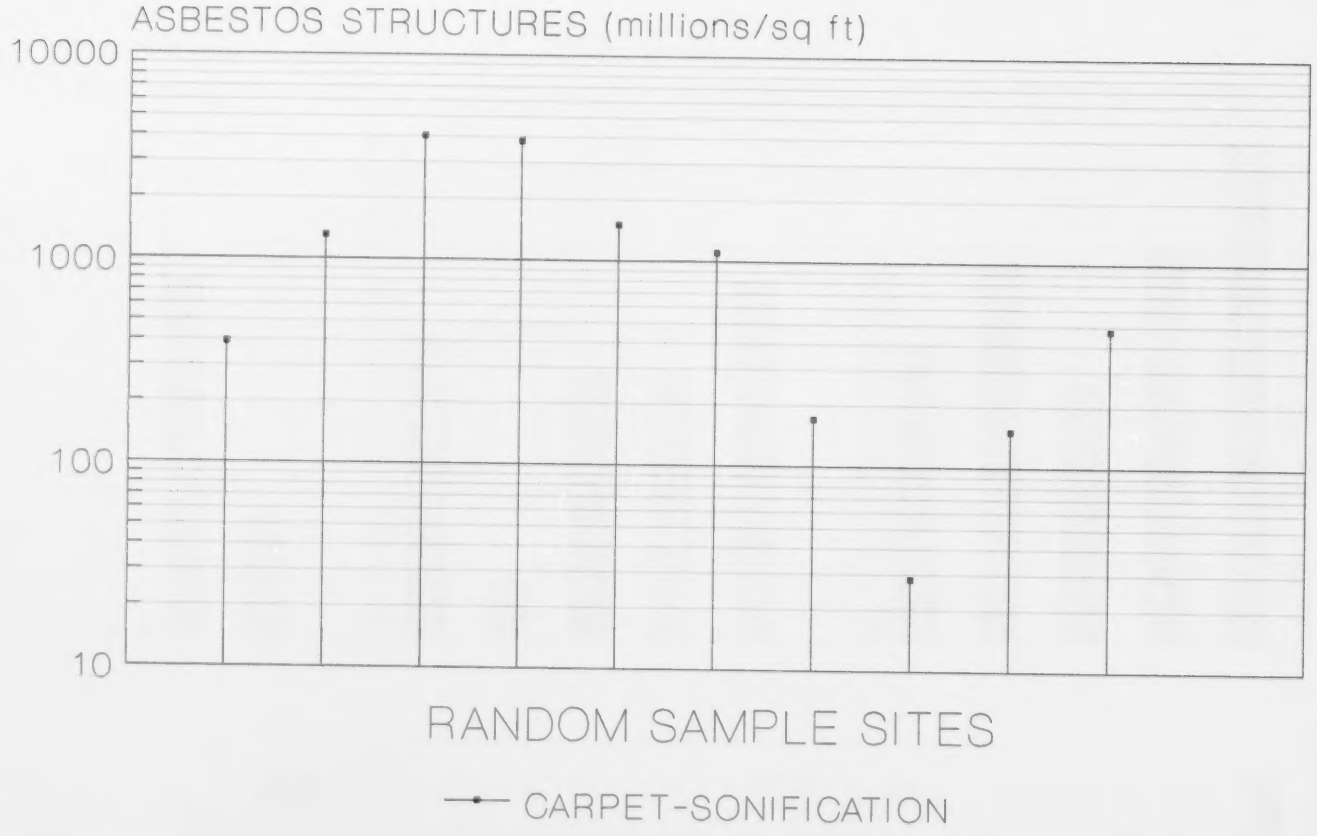
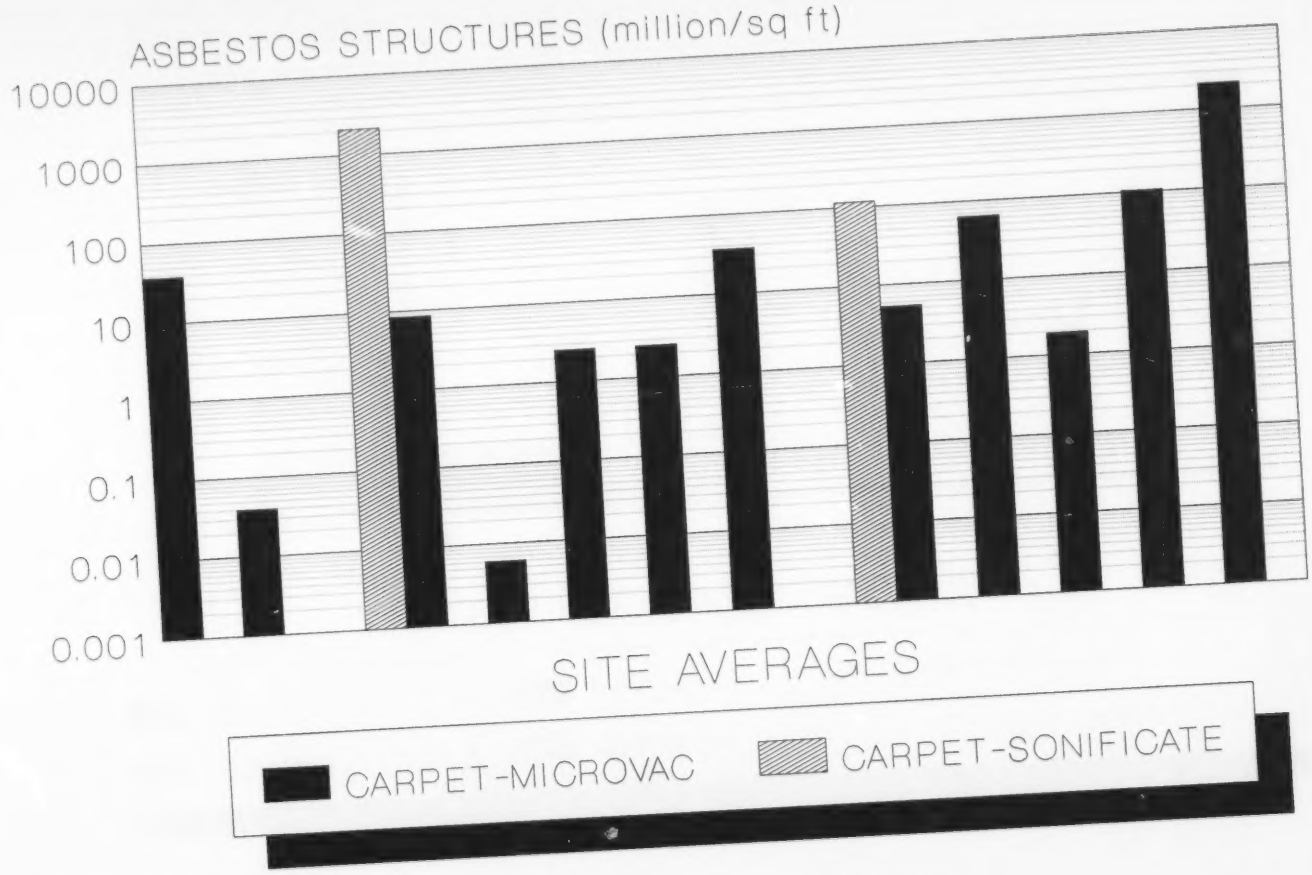


Figure 5. COMPARISON OF CARPET MICROVAC VS SONIFICATE



ANALYSES BY TEM

Figure 6. EFFECT OF TIME SINCE CLEANING
SURFACE DUST

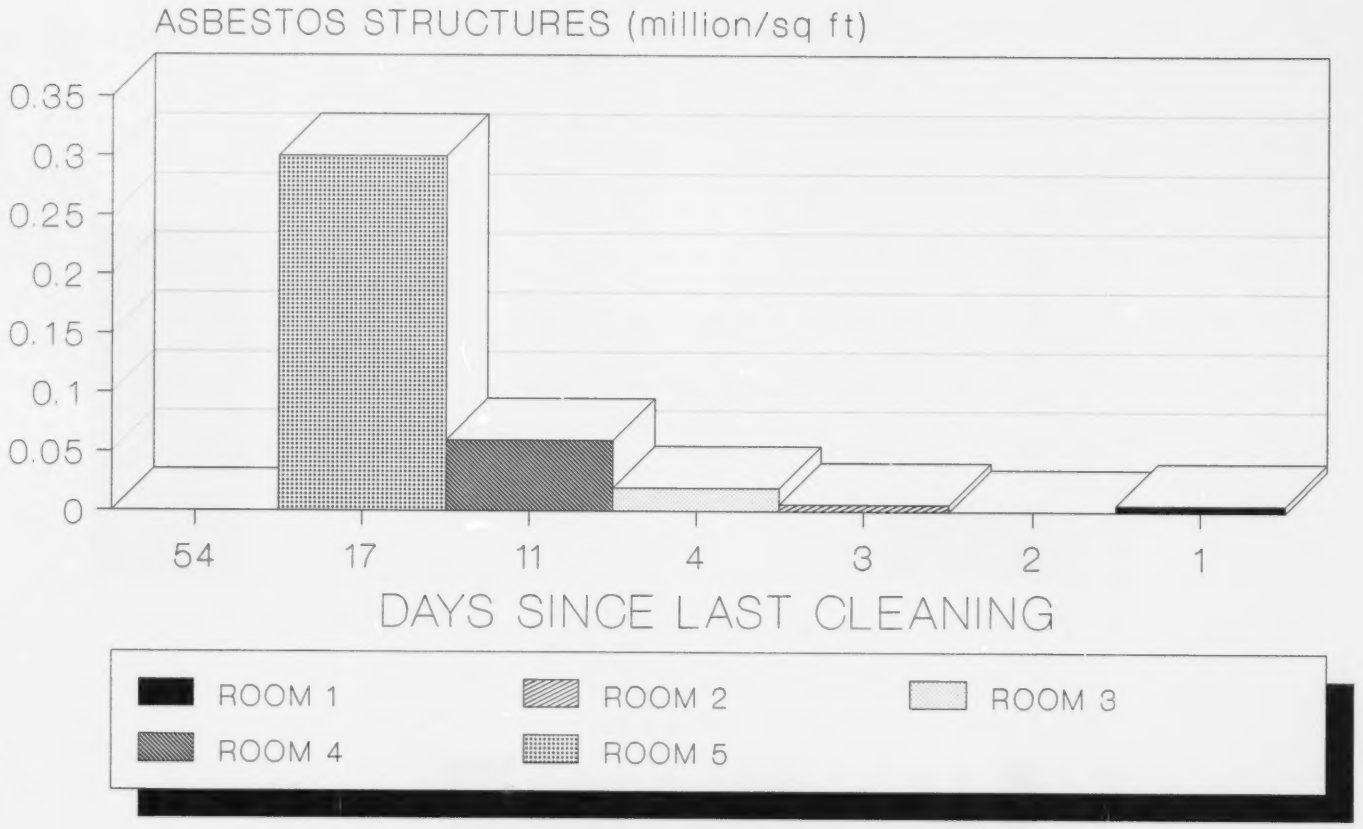


Figure 7. EFFECT OF TIME SINCE CLEANING CARPET

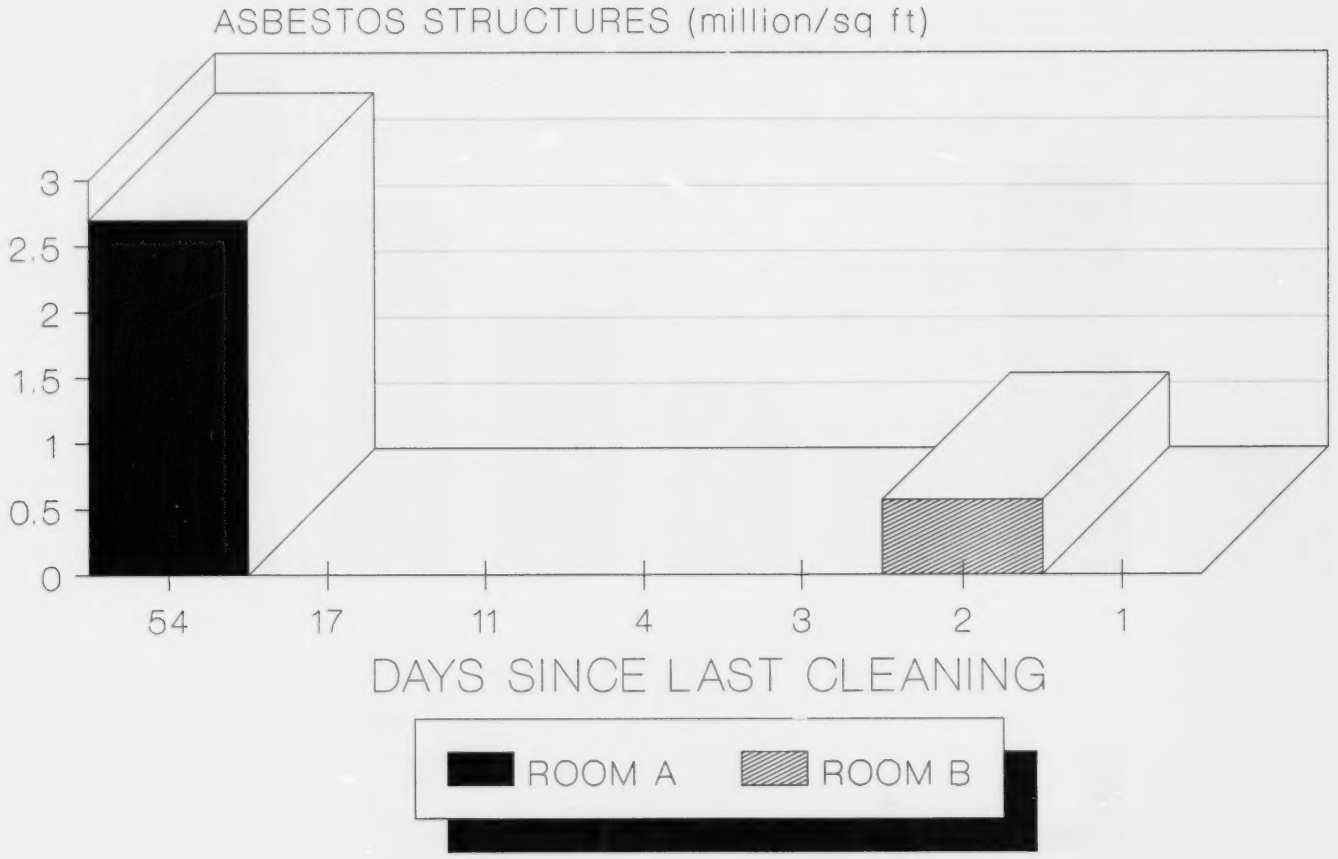
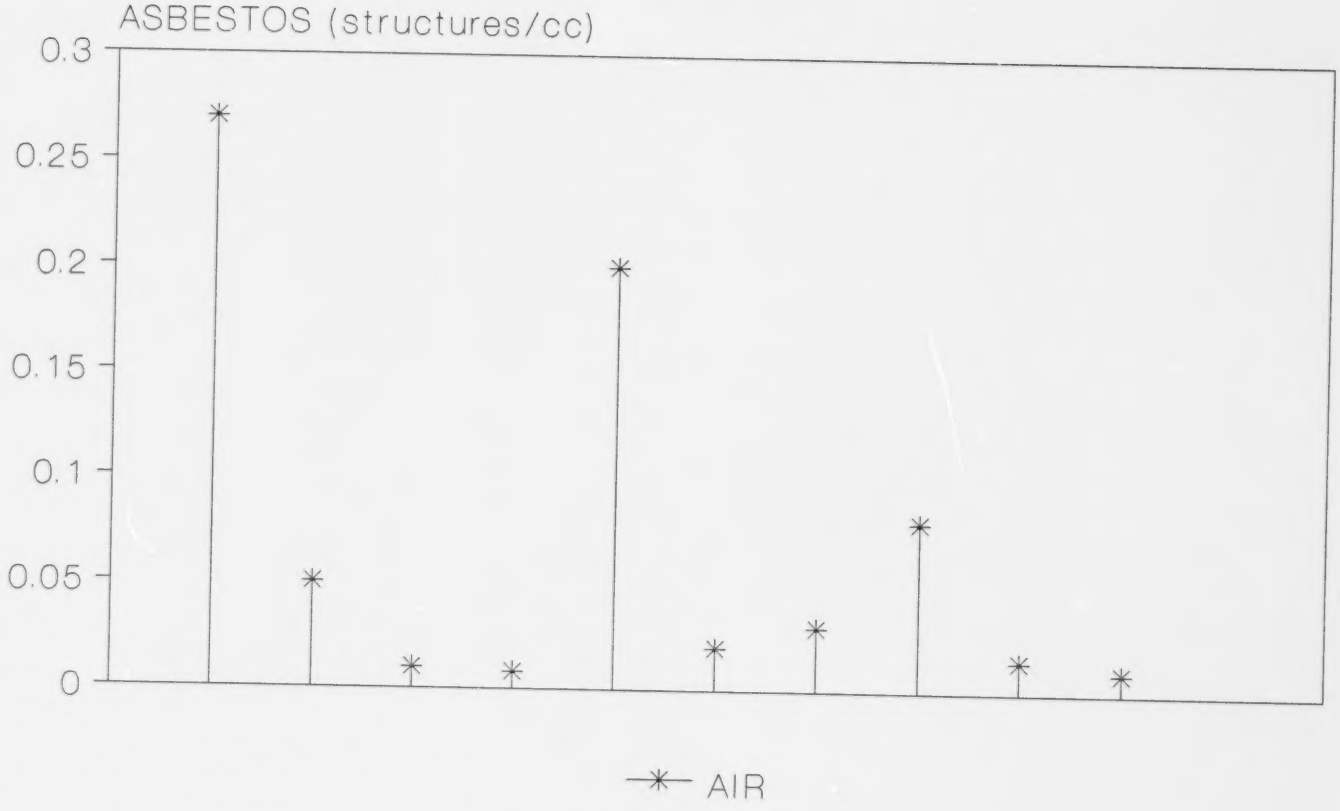


Figure 8. EFFECT OF TIME SINCE CLEANING

Figure 9. TYPICAL AIR LEVELS
Passive sampling



ANALYSES BY TEM

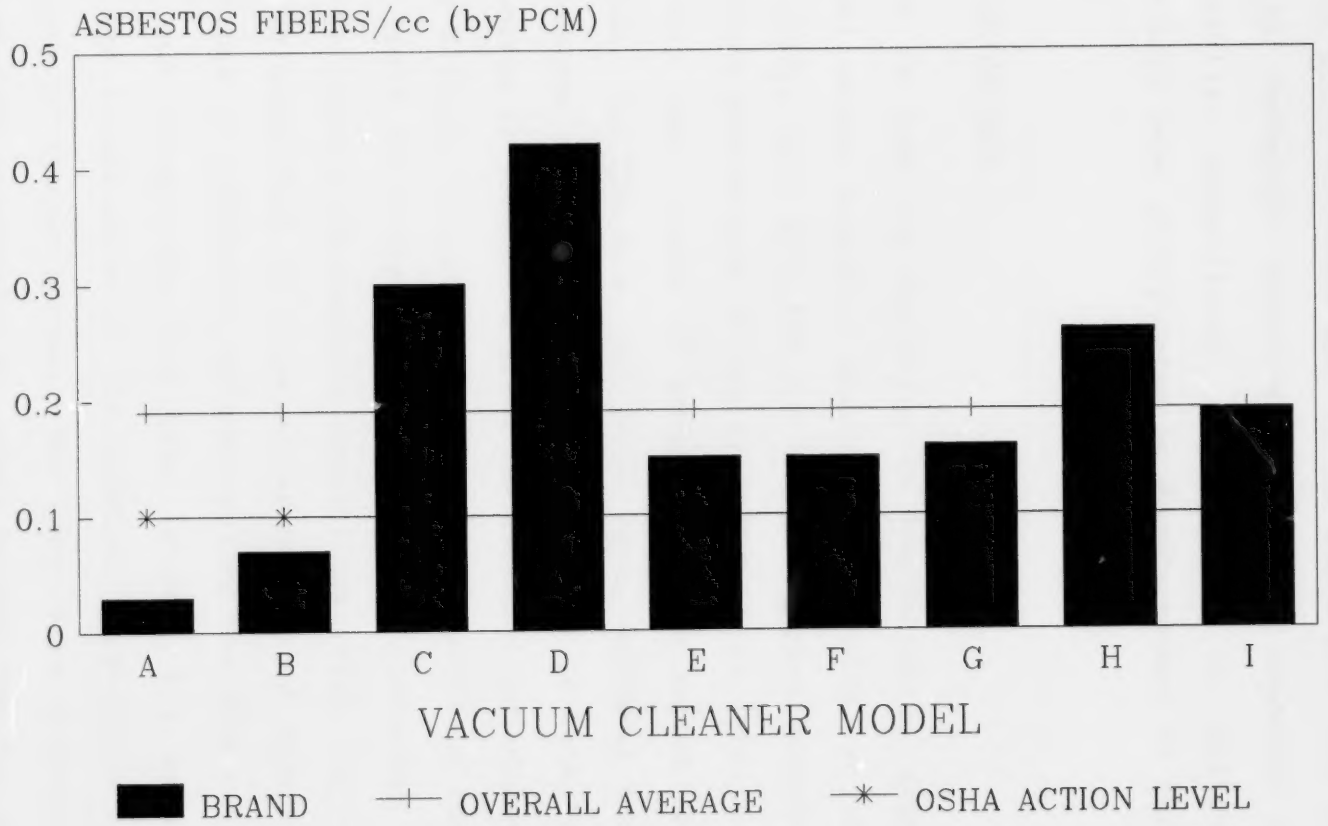
typical outdoor (ambient) asbestos levels are near 0.005 asbestos structures/cc.

ASBESTOS VACUUMS

Most of the published information on the effectiveness of vacuum cleaners for use on asbestos was done at Texas A&M University by Wilson (4), Daniels (5), Johnston and Clapp (6), and Johnston (7). In the series of studies done by these researchers for NIOSH, they tested the effectiveness of nine vacuums (seven different manufacturers), which were designed for asbestos use. All of the systems used multiple filters. Five of the nine were classified as high efficiency (HEPA). Johnston and Clapp placed the vacuums, one by one, in a clean room. The intakes were attached through a sealed connector to an inlet hopper in the adjacent room. The vacuum motor was started and measured amounts of "pure" chrysotile asbestos were fed into the intake hopper and drawn into the vacuum cleaner located in the adjacent "clean" room. Samples were collected at various locations inside the "clean" room while the vacuum was operating. Analyses were made by PCM and reported as asbestos fibers, which was a valid presentation since only "pure" asbestos was introduced into the vacuum inlet.

The results are shown graphically in Figure 10. SIgnificantly, only two of the nine vacuums tested met the now-current OSHA action level of 0.1 fibers/cc by PCM. In reality, the performance of eight of the nine systems was disappointing

Figure 10. ASBESTOS VACUUM CLEANER EMISSIONS – MODEL COMPARISON



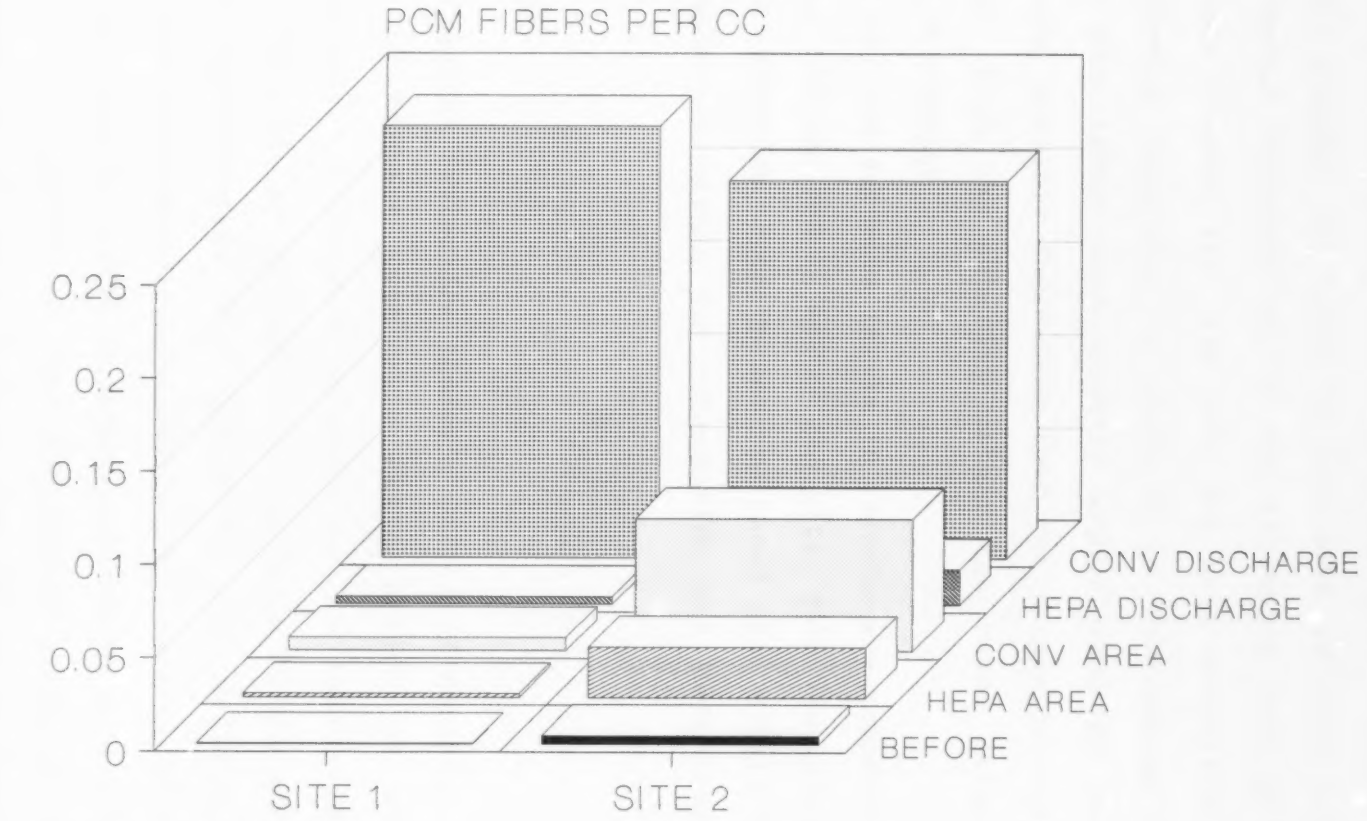
W.L. Johnston, 1985

and would result in unwarranted exposures during normal use. The fact that the results were alarming using PCM underestimates the exposure that would have been seen if TEM would have been used as the analytical technique. Johnston's tests were conducted around 1980; hopefully, significant improvements in design and performance have been incorporated by manufacturers in the past eight years.

CARPET VACUUMING DATA

Research is just now beginning on evaluation of exposures during actual carpet vacuuming operations. Karaffa, et al (8), in an EPA study, used both PCM and TEM to compare conventional and HEPA vacuum performance at two sites, which we later learned had relatively lower levels of asbestos in the carpet than in other studies. The TEM data, not shown here, suffered from the small air volumes sampled during the brief time it took for the custodial worker to vacuum the area; few asbestos structures were seen on the filters, therefore, most asbestos counts by TEM were below the limit of detection. The study is currently being redesigned to improve TEM-sampling sensitivity. From the low TEM counts, it is clear that no gross contamination was occurring as a result of use of either the conventional or the HEPA vacuum at these two ACM sites. The PCM data (Figure 11) were more definitive and illustrative of the relative performance between the two types of vacuum systems. The observable difference in fiber release (not necessarily asbestos) between the two systems was statistically significant.

Figure 11. CARPET VACUUMING
PCM AVERAGES



KARAFFA, ET AL; 1988

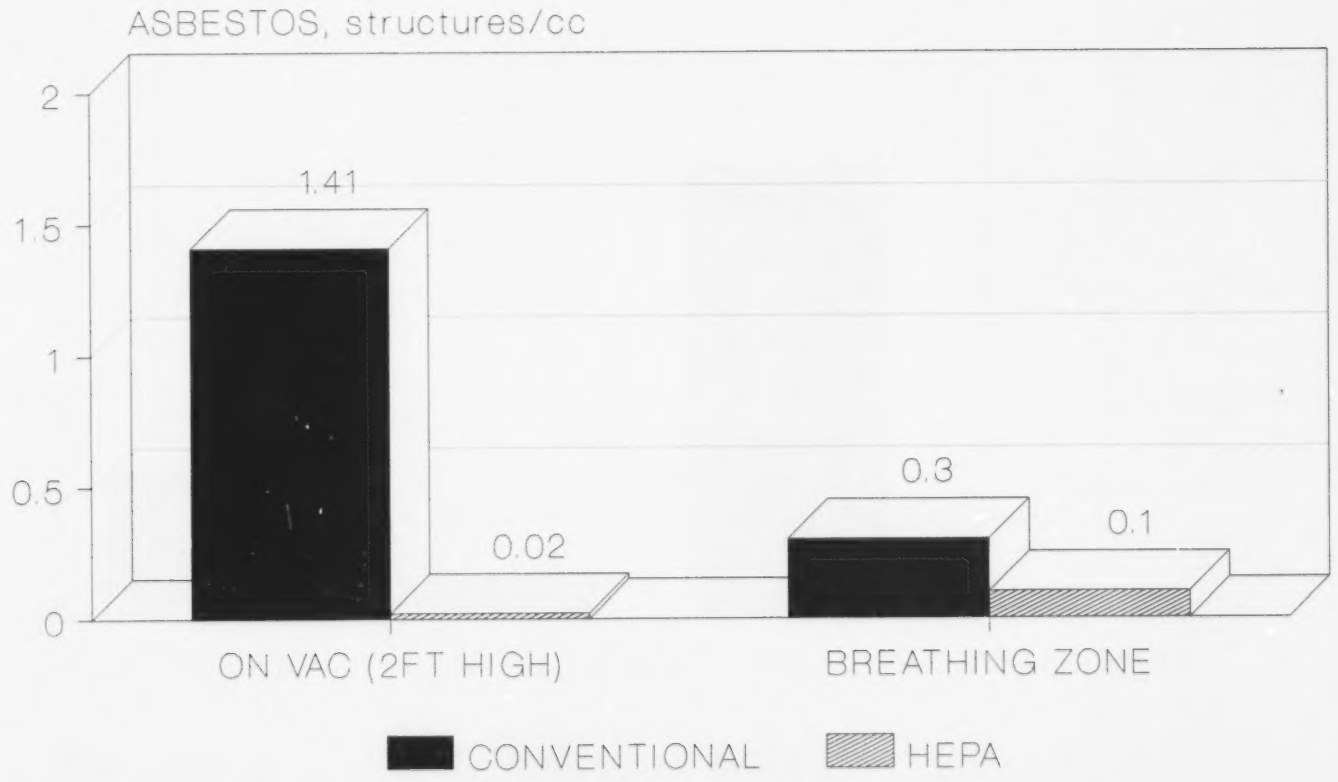
McCrone Environmental Services conducted a small, observational study on carpet vacuuming. Although the study was not statistically designed, the resulting data trends are interesting and support the logic of increased asbestos levels both at the vacuum discharge and at the breathing zone of the custodial worker (Figure 12). The HEPA was more successful in containing asbestos emissions, although it is interesting that the breathing zone levels were slightly higher than the vacuum discharge levels, possibly indicating that the mechanical action of the vacuum, plus the activity within the room, released asbestos from the carpet.

In Figure 13, the asbestos levels in carpets are compared in 1) two adjacent offices and 2) before and after HEPA vacuuming in a third office. Although these values are based upon single data points, the apparent trends are interesting and deserving of further study.

FUTURE RESEARCH

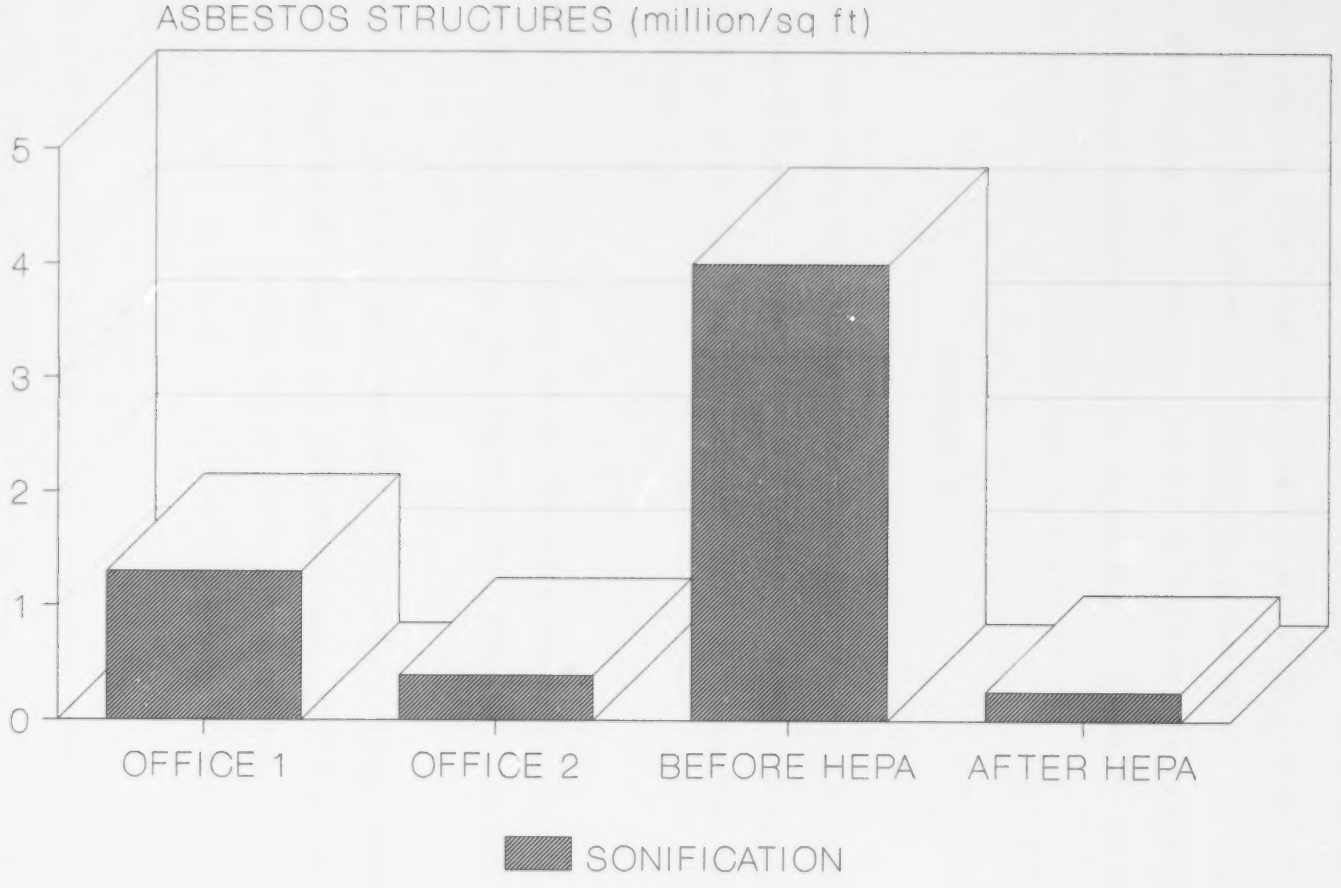
The Environmental Protection Agency's Office of Research and Development, in concert with with EPA's Office of Toxic Substances, NIOSH, and support contractors, is dedicated to improving the state of the art concerning guidance to the public on effective technologies for Operation and Maintenance activities in buildings containing asbestos. The results of this research will not only be useful to schools, but also to all ACM-buildings, including residences. The O&M-related research is a significant component of EPA's current research on engineering

Figure 12. CARPET VACUUMING
AIR LEVELS



Office bldg - ANALYSES BY TEM

Figure 13. CARPET VACUUMING



Office bldg - ANALYSES BY TEM

controls for asbestos. This year, EPA intends to study the O&M activities that we consider to have the greatest potential for worker exposure to asbestos (carpet vacuuming and dusting/cleaning are high on that list). The goal of this research, to be conducted at a captive site where we can best control the many variables, is to evaluate the adequacy of existing control systems and , if necessary, to modify or develop technologies to assure control system performance.

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